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How do some teachers of primary mathematics view the impact of the Singapore textbook schemes?

The use of adapted versions of Singapore textbooks for the teaching of primary mathematics is being trialled, supported through the mathematics hubs as part of an initiative by the Department for Education to explore whether importing East Asian teaching approaches into England improves standards in Mathematics. The aim is to facilitate teachers in embedding the Mastery approach to mathematics teaching (NCETM, 2015).

Can the use of a good textbook help to develop teachers' pedagogy and practice? Fan et al (2013) state that textbooks can be an important factor in the development of teaching approaches in mathematics, introduce teachers to different teaching approaches and influence the development of their pedagogy. The National Association of Mathematics Advisors say that textbooks can be used to support teachers in developing teaching approaches which could result in their students gaining mastery in mathematics but counsel that such texts cannot replace the good teaching skills necessary to enable their students to be successful in mathematics (NAMA, 2015).

The concept of Mastery is not new. In 1968 Bloom stated that it should be possible for 95% of students to attain Mastery of a subject given appropriate teaching approaches and sufficient length of time for each individual student. In his view a student's *aptitude* can be translated as the length of time it takes in order for them to master a given subject. Some students will master the subject in a short space of time whilst others will take longer and may need to experience a variety of teaching approaches in order to attain Mastery. Bloom recommended that the classroom be a non-competitive environment where pupils work towards their learning goals and are formatively evaluated to ascertain whether or not they have mastered the concepts. No grades are given and feedback focuses on what the student needs to do in order to achieve the learning goals / master the concepts. This idea would later be developed by Dylan and Wiliam (1998) whose report prompted the Assessment for Learning policy in England.

In 1976 Skemp's seminal article described relational understanding in mathematics which requires students to develop a conceptual picture of how mathematics works and what underpins the procedures they have been taught. (Instrumental understanding of mathematics, on the other hand, describes a different type of learning when the student learns sets of rules or procedures for solving mathematical problems with little understanding of why they work or of how they could be applied to different problems). To develop relational understanding requires more time and effort at the beginning but once *mastered* leads to students being able to adapt their knowledge and skills to new contexts and to work out from first principles if they cannot remember the procedure.

Askew et al (1997) described the *connectionist* teacher as one who believes that most pupils are able to learn mathematics provided that they are taught using the appropriate teaching approach and in this they follow the view of Bloom (1968). The label connectionist refers to the way teachers help their pupils make links between different parts of mathematics and in applying the mathematics they know to new situations. The development of reasoning and justification and therefore of discussion in mathematics is considered important.

Textbook design in Shanghai and Singapore

In China, Mathematics textbooks play an important role in developing teachers' effective classroom teaching (Li et al, 2009). This has an historical basis since in the 1950s the Peoples' Education press was set up to develop a national textbook for mathematics in China alongside the Mathematics syllabus. A dedicated team of scholars worked to produce the textbook (and syllabus) based on educational principles. Although since the 1980s this work has been opened up to other publishers each new textbook has to go through an approval process and to be piloted in a sample of schools, after which the textbooks are constantly reviewed and new revisions go through the testing process, taking into account feedback from teachers and Mathematics academics (ibid).

In Singapore educational policy has been influenced by Skemp and has had a profound effect on mathematics teaching and student achievement since the 1980s (Maths No problem Website, 2016). Singapore now has a centrally organised system of education and a nationally designed mathematics curriculum, which their textbooks follow. The Singapore mathematics texts are written on the assumption that students will have gained mastery of what has been taught previously and therefore do not repeat content of the same topic being taught at a higher level in later school years.

Alongside the development of well-designed textbooks in high performing jurisdictions such as Shanghai and Singapore, another important factor in high student achievement is likely to be the ongoing continuous professional development (CPD) available to the teachers. For example teachers in Shanghai work within a strong collaborative culture with time allocated in the school week for co-planning with colleagues, and membership of Lesson Study groups (Lim, 2007).

Collecting teachers' opinions on the new textbooks

I visited three primary schools, two of which have used Inspire Maths™ from Spring 2015 beginning with y1 and then y2 and one of which has used Maths No problem™ from Autumn 2015 with all year groups. Nine teachers overall participated in interviews which took place in the autumn and summer terms of 2015-16. Their experience ranged from early career through mid career to over twenty years in teaching. Two of the interviewees were the mathematics co-ordinators in their school and had undertaken the MAST programme. One school is situated on the edge of a large city serving an area of high deprivation, another in a fairly affluent suburb, and the third was a small village school.

Themes which emerged from the interviews

There was clearly a consensus of opinion which was very positive towards the textbook schemes. Between all nine participants the themes which emerged were common to all, no matter the length of time they had been teaching. Three main themes were identified:

- The textbook scheme (comprising the textbooks, pupil workbooks, teacher guides and teacher professional development offered alongside) provides a *well-structured mathematics curriculum*.
- The textbook scheme *promotes mixed ability teaching*.
- *Teachers continue to need good pedagogic skills* in order to make the best use of the textbook scheme.

The provision of a well-structured curriculum

It has become clear, from talking to the teachers who participated in the interviews and from informal discussion with other teachers, that there has been no well-structured curriculum to support primary mathematics since the National Numeracy Strategy was shelved in 2010 at the change of government. The National Curriculum, 2013, provides a set of learning objectives for primary mathematics year by year, but does not provide a sufficiently structured guide to support teachers in delivering the curriculum.

“When the Numeracy Strategy went out of fashion and was removed, I felt that removed a bit of structure for people. For the last few years it has been up to teachers to pick out schemes of work, to get units. I can see the benefits of that if you are a confident maths teacher but for those people who are newly qualified or not confident, I think removing those structures over time did have a negative impact”.

It appears that primary teachers in England, most of whom are not mathematics specialists, have been left without the support that a well-planned curriculum can provide. The new text book schemes appear to provide the structure, guidance and support needed for teaching mathematics. Each textbook scheme is supplemented with a teacher’s guide with a long term plan for each year and medium term plans for each unit of work. The guides provide a sequence of what is expected to be taught and in which order and there is also advice on how to approach the teaching of each topic. Models which support the development of understanding of the concept of number in the pupils, such as the part-whole model and the bar model, become familiar to them and continue to support them as they move up through school.

“It’s all set out ready for you. There’s a teacher’s guide so there’s a long term plan and there’s a plan for each unit which guides you through which order you’re going to do it in. There’s almost a script but it’s not written as a script”.

“The teacher book you get with it is quite self-explanatory for what you need to do. And it’s very clear about the sequence of how you teach this”.

Through the scheme mathematical concepts are introduced carefully. The scheme promotes the teaching of concepts in a thorough way with the aim that all pupils develop a deep understanding of the concepts. Hence the participating teachers find that they have moved away from the idea that they need to cover the learning objectives set down for the level or year group, towards the concept of mastery of mathematics by all their pupils.

“So I went right back to basics, thinking about parts being equal, and I wouldn’t have necessarily done that before Mastery. I made sure they had a deep understanding of division before we did fractions”.

Concepts in mathematics are developed through careful use of problems. The problems, found in the textbooks and pupil workbooks, are varied and place high demands on conceptual understanding. At the same time, for example in Key Stage one, the numbers involved are not big. At the start of year one the pupils develop their conceptual understanding of number by mostly working with numbers up to ten.

“It builds up through word problems. Ella has fifteen sweets and she has three pots, how many sweets will each pot have? Those sorts of word problems”.

There is a focus on the application of mathematics rather than on rote learning. To facilitate this pupils meet problems which are presented in varied ways, in different contexts and using varied vocabulary. The scheme promotes the use of different kinds of concrete equipment and visual imagery to support pupil development of the concepts. Several teachers quoted the mantra “Concrete, pictorial, abstract”.

“We’ll start off with concrete things like cubes or Numicon or beads. Then we’ll do the same things but with pictures of the things and then we’ll bring in the numbers and do the abstract of the things. So they (the children) learn the same thing in three different ways”.

Mathematical communication is also developed by the promotion of mathematical vocabulary and the use of written symbols. There is plenty of interactive talk between teacher and pupils and between pupils.

“Another big part of it is speaking in sentences and it really encourages that”.

Teachers found that the structure provided by the teacher’s guide, textbooks and pupil workbooks supported their planning to the extent that their planning time for mathematics lessons decreased. The resources provided by the scheme are easily adaptable. The outcome of all of this has been that teachers use their planning time to think about how they will deliver the mathematical ideas to their pupils, for example some teachers developed power-point presentations which provide animated visual representations to help their pupils to see and understand. The following comment from a maths lead teacher explains how the structure of the curriculum promoted through the books helps free up planning time to think more clearly about how to teach mathematical concepts.

“I don’t think people are spending less time planning their maths but what they are doing is, they’re not spending time gathering resources, they’re not spending time thinking about what they need to do next, because it’s all there. Planning is much more worthwhile because they’re concentrating on how to deliver an idea, make it clear for the children”.

Promotion of mixed ability teaching

Before the use of the textbook scheme two of the three schools practised a form of setting by ability, through the use of differentiated tasks, for higher, middle and lower attaining pupils. However the philosophy behind the textbook scheme is that all children in a class should be taught together. The issue then arises of how to manage the children’s work when some complete the work quickly and others need more time to grasp the concepts. Teachers have addressed these issues by consolidation of work and the careful development of conceptual understanding for the lower attainers, and the extension of higher attainers by breadth and depth, rather than by acceleration through the curriculum. Intervention for those pupils who are falling behind the rest of their class is usually undertaken on the day.

“What’s interesting is you differentiate more by intervention. They’re working very often in mixed ability groups, mixed ability partnerships. The expectation therefore is that every child will do exactly the same thing but they might have a bit of extra support outside the classroom, to get them to the same point”.

Pupils also work in mixed ability pairs and this is seen as beneficial for both. The higher attaining pupil gains because they provide support to their peer and being asked to explain the mathematics to their peer helps to consolidate their own learning. The lower attaining pupil gains through talking about mathematics with a more confident pupil. The opinion of the teachers was that this boosts the confidence of the less able pupil and raises their expectation of what they can achieve in mathematics.

The teachers have also been surprised to find that children they had previously labelled as high attainers were found not to have any better understanding of number concepts than lower attaining children, even though they could operate with bigger numbers.

“The children we thought were our higher achievers were actually not much further on than other children in their understanding of number, That was really eye-opening because you automatically assume that because they can count that they actually understand that six always comes after five or that seven is two more than five. They can count to any number you give them but they still don’t have that understanding of where the numbers fit in with each other”.

It had always been assumed that the best way to challenge and extend children who were able to manage the work with smaller numbers was to give them larger numbers to work with. However that is not the way promoted through the textbooks.

“So previously you’d plan something and you’d think -I’m teaching two digit numbers, the extension must be moving onto three digit numbers, and actually it’s really not”.

How difficult was it to keep all of the pupils in the class together on the same learning objective? How did the teachers manage the interventions needed for pupils who were struggling to grasp the concepts? Some of this took place within the regular lesson.

“If we have children who don’t feel confident then they come to the carpet and we can do a ‘sit on the carpet’ intervention and then they move back to work with their partner”.

Or it might be that the pupils who needed extra input were given extra time on top of the regular maths slot.

“Is there a misconception that needs addressing? Quite often there isn’t but there are times when I do hold back a number of them. They’re absolutely in their element anyway, they’ll quite happily work for an extra half hour, some of them”!

The importance of good pedagogic skills

All interviewees commented that it is still necessary to have good pedagogic skills if the best use is to be made of the textbook scheme. Teachers need to know how the textbook scheme should be used which demonstrates the importance of CPD / training in using the scheme, whether this is obtained through the courses offered by the publishers of the textbooks or through cascaded training in school.

“I think it’s very difficult to use the textbooks to their potential, and as they’ve been designed, if you just use them superficially with no understanding of what Mastery is”.

“I was fortunate to go on the training and I think in some ways it helps you to understand the mind-set. If you come straight to the book you’d think ‘it’s just a book’ but if you understand what the reasoning behind it is, and how they use modelling within the book, even the way the book’s laid out shows there’s a purpose behind it”.

The books on their own are not considered sufficient to guide teachers to an understanding of Mastery. The concept of Mastery may underpin the philosophy behind the books but the CPD, to develop an understanding of Mastery in mathematics, was considered most important.

“I find that the text books give us a start. I don’t think they equate to Mastery. I think if you give them the books and say –That’s Mastery – it isn’t. Mastery is an approach, as opposed to just the books. I think it’s very difficult to use the textbooks to their potential and as they’ve been designed, if you use them superficially with no understanding of what Mastery is”.

All teachers in the interviews related how they found it necessary to modify or supplement the materials provided by the textbook scheme in order to tailor them to the needs of their own class. Sometimes the teachers spent longer on a topic than indicated in the scheme if they felt that their pupils needed longer to grasp the concepts.

“What I like to do is, if they’re doing the Part-Whole model with cubes alongside, I like it to be able to appear on the screen so that they are not just looking at a solid picture that doesn’t move in the book. For those children that need to see the pieces coming together, they can and can see how it relates”.

However the view of the scheme is overwhelmingly positive and teachers said that it had given them new approaches to the teaching of mathematics. Some teachers commented that working with the scheme had consolidated their own understanding of mathematics, alongside their skills at teaching the subject.

“It is a new way of teaching and a new way of organising your classroom and thinking”.

Conclusion

Guskey (2002) stated that, for teachers to embed new practice they need to see evidence that their students make better progress as a result. He also talked of the importance of CPD since sustaining a change in teacher practices should be seen as an ongoing process that needs investment in teacher development and support. The textbook trial appears to have made a good start in this respect.

From the interviews it would appear that the textbook schemes, backed up by the CPD on offer, have been effective in changing teachers' practice of teaching mathematics. Those aspects of Mastery learning such as the view that almost all children can master mathematics given the most appropriate teaching approaches, have become embedded in the beliefs of the teachers who participated in the interviews. They talked of careful development of mathematical concepts and of the value of getting children to talk and explain the mathematics.

Pedagogical understanding of the nature of mathematics and what it means to encourage mastery learning in their pupils was viewed as being important in making the best use of the textbooks. The picture does look very promising regarding the use of the textbooks but it must be remembered that the teachers in the schools where the interviews were conducted were early adopters and that most interviewees had received the CPD delivered by the publishers of the textbooks. At least two teachers from each school attended the five days of CPD and were expected to cascade this training to their colleagues but it is not certain how this equates to the experience gained by actual attendance at the training.

The key stage 1 and key stage 2 SATs were not taken account of by the publishers of the textbooks and I was told in all three schools that the mathematics scheme had needed to be modified in order to ensure that the pupils were prepared for the SATs. In one school where this had been the first year of using these particular textbooks, the teachers thought that they would be better prepared in the future.

“So for next year we've got a contingency plan there in terms of how far we should have got through by a certain time”.

The overall picture from these interviews is very positive and would suggest that the investment in the schemes and in teacher development is worthwhile, with a few caveats. I would suggest, the textbooks themselves be regularly reviewed and improved through feedback from teachers as they are in Singapore and Shanghai. CPD with inbuilt opportunities for discussion and feedback should also be a regular feature and not only provided when the school first buys into the textbook scheme. Furthermore, the high cost of buying into these textbook schemes for the whole school, which includes purchasing pupil workbooks each year may need to be reviewed with ways found to bring down the cost.

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